# CEE-245

# SUEVEYING

# LECTURE : CONTOURING

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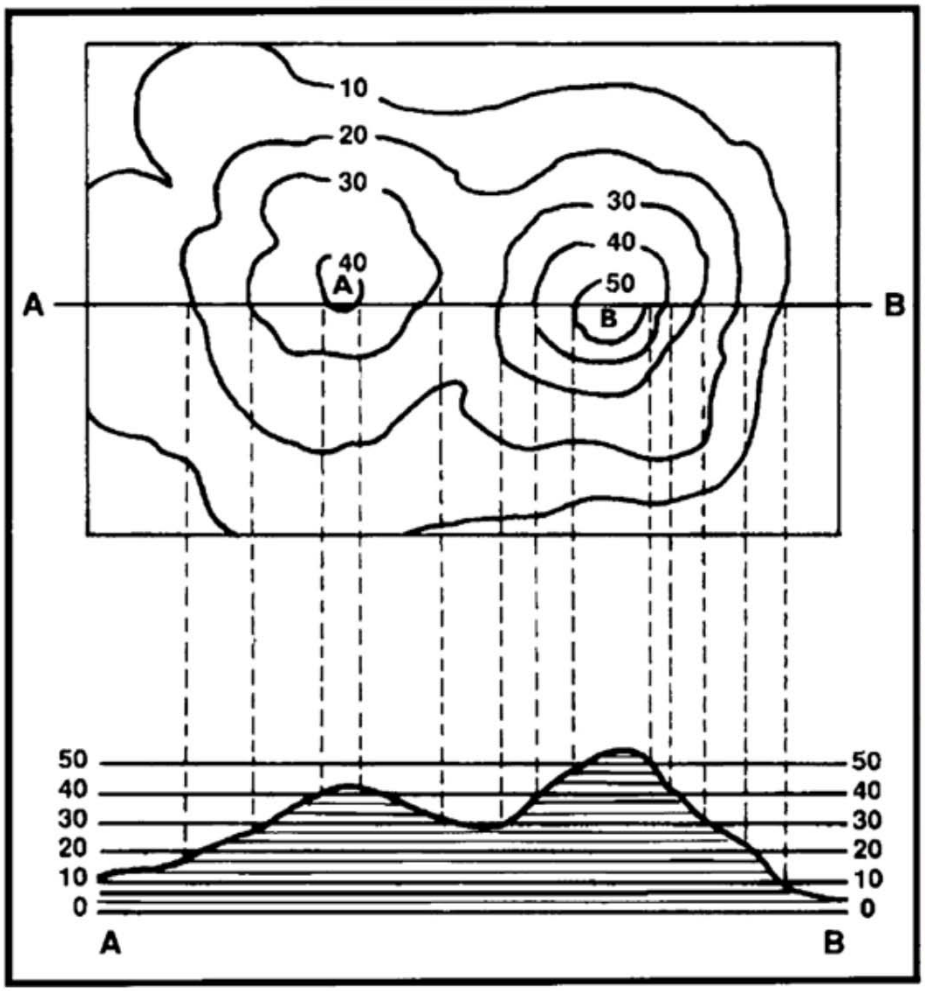
# CONTOURING

- Contours are imaginary lines joining points of equal altitudes upon the earth surface with reference to a fixed datum.
- It is a line in which the surface of ground is intersected by a level surface.
- A map showing contour lines is known as Contour map.
- A contour map gives an idea of the altitudes of the surface features as well as their relative positions in plan serves the purpose of both, a plan and a section.
- The process by which a contour map is prepared is known as contouring.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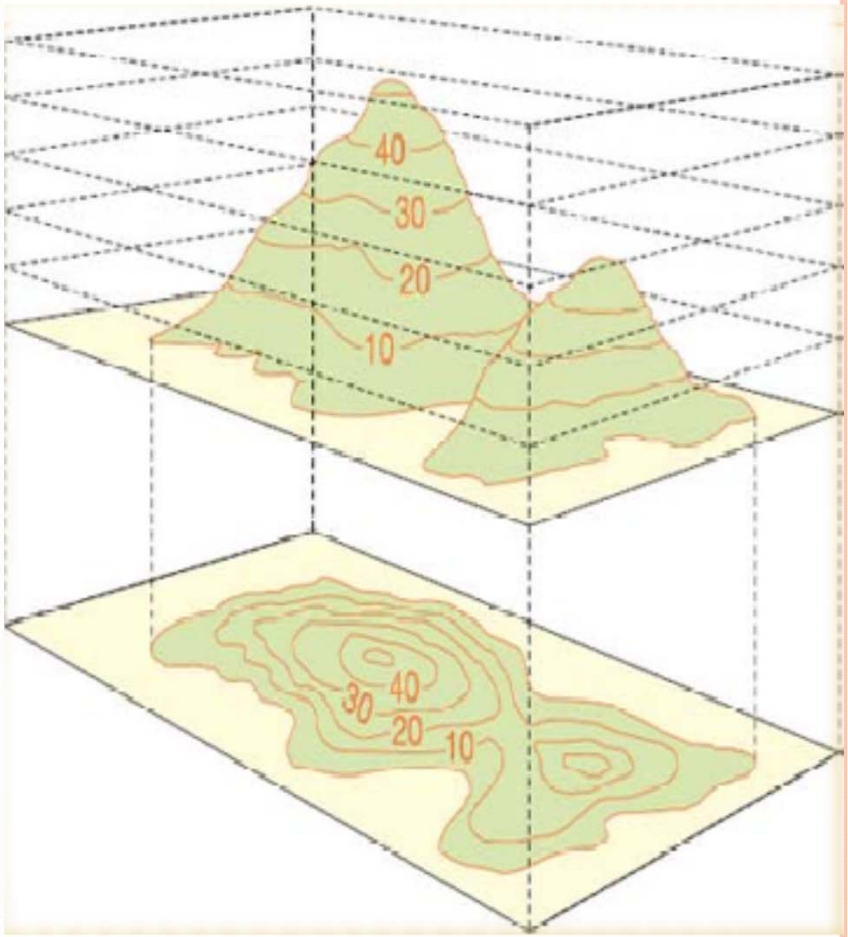
40
30
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40
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10

# PURPOSE OF CONTOURING

**Contour survey is carried out at the starting of any engineering project such as a road, a railway, a canal, a dam, a building etc.**

i. For preparing contour maps in order to select the most economical or suitable site.
ii. To locate the alignment of a canal so that it should follow a ridge line.
iii. To mark the alignment of roads and railways so that the quantity of earthwork both in cutting and filling should be minimum.
iv. For getting information about the ground whether it is flat, undulating or mountainous.
v. To find the capacity of a reservoir and volume of earthwork especially in a mountainous region.
vi. To trace out the given grade of a particular route.
vii. To locate the physical features of the ground such as a pond depression, hill, steep or small slopes.

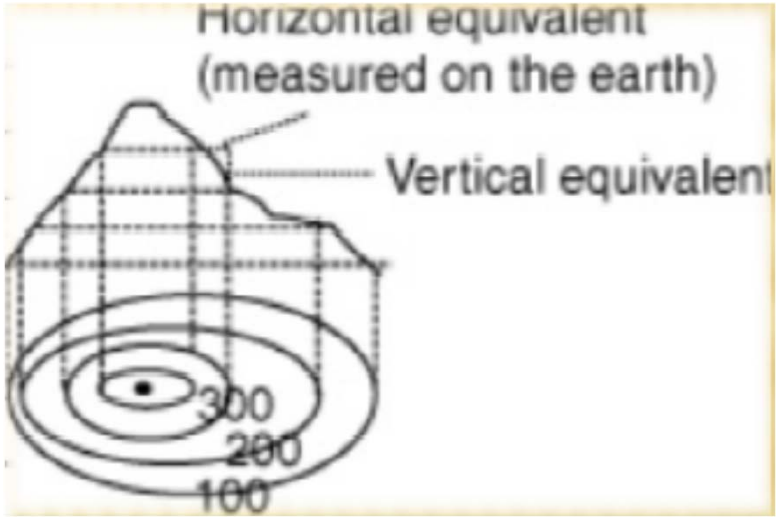
## Contour Interval

- The vertical distance between any two consecutive contours is called contour interval.

## Horizontal Equivalent

- The horizontal distance between two points on two consecutive contours is known as the horizontal equivalent

**The contour interval is constant between the consecutive contours while the horizontal equivalent is variable and depends upon the slope of the ground.**



# FACTORS ON WHICH CONTOUR INTERVAL DEPENDS

The contour interval depends upon the following factors:

## (i) The nature of the ground:

- The contour interval depends upon whether the country is flat or highly undulated.
- For every flat ground, a small interval is necessary.
- If the ground is more broken, greater contour interval should be adopted, otherwise the contours will come too close to each other.

## (ii) The scale of the map:

- The contour interval should be inversely proportional to the scale
- If the scale is small, the contour interval should be large.
- If the scale is large, the contour interval should be small.

## (iii) The purpose and extent of the survey:

- If the survey is intended for detailed design work or for accurate earth work calculation, small contour interval is to be used. The extent of survey in such cases will generally be small.
- In the case of location surveys for lines of communications and for reservoir and drainage areas, where the extent of survey is large, a large contour interval is to be used.

## (iv) Time and expense of field and office work:

- If the time available is less, greater contour interval should be used,
- If the contour interval is small, greater time will be taken in the field survey, in reduction and in plotting the map.

# COMMON VALUES OF THE CONTOUR INTERVAL

- The following table suggests some suitable values of contour interval:

| *Scale of map* | *Type of ground* | *Contour Interval (metres)* |
|---|---|---|
| Large (1 cm=10 m or less) | Flat | 0.2 to 0.5 |
| | Rolling | 0.5 to 1 |
| | Hilly | 1, 1.5 or 2 |
| Intermediate (1 cm=10 m to 100 m) | Flat | 0.5, 1 or 1.5 |
| | Rolling | 1, 1.5 or 2 |
| | Hilly | 2, 2.5 or 3 |
| Small (1 cm=100 m or more) | Flat | 1, 2 or 3 |
| | Rolling | 2 to 5 |
| | Hilly | 5 to 10 |
| | Mountaineous | 10, 25 or 50 |

The values of contour interval for various purposes are suggested below :

| | *Purpose of survey* | *Scale* | *Interval (metres)* |
|---|---|---|---|
| 1. | Building sites | 1 cm = 10 m or less | 0.2 to 0.5 |
| 2. | Town planning schemes, reservoirs, etc. | 1 cm = 50 m to 100 m | 0.5 to 2 |
| 3. | Location surveys | 1 cm = 50 m to 200 m | 2 to 3 |

- For general topographical work, the general rule that may be followed is as follows:
- $$Contour\ interval = \frac{25}{No.\ of\ cm\ per\ km}\ (meters)$$
$$= \frac{50}{No.\ of\ inches\ per\ mile}\ (feet)$$

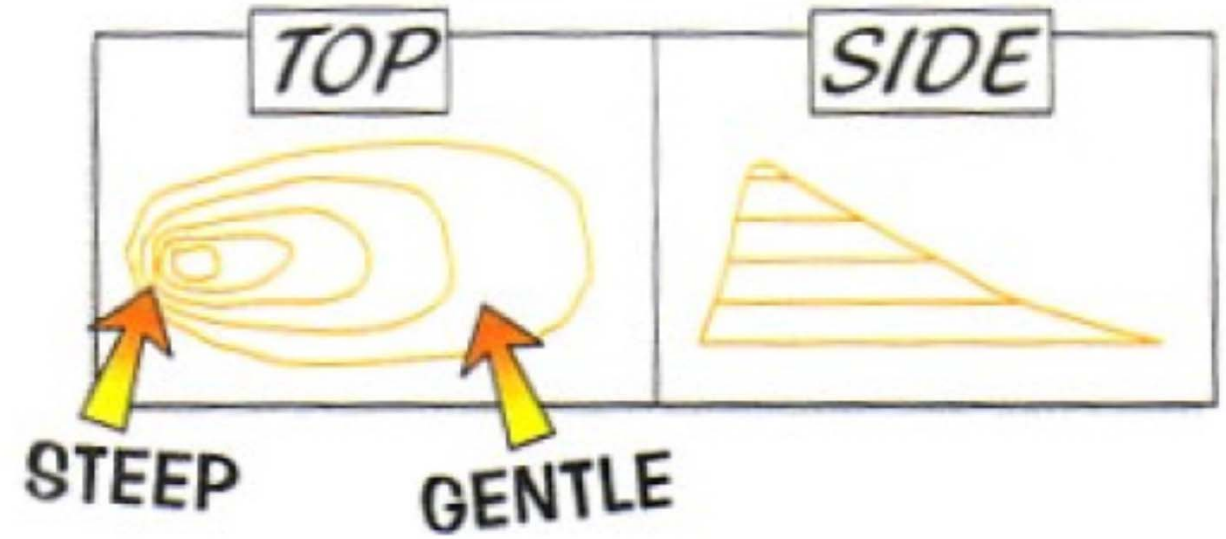
# CHARACTERISTICS OF CONTOURS

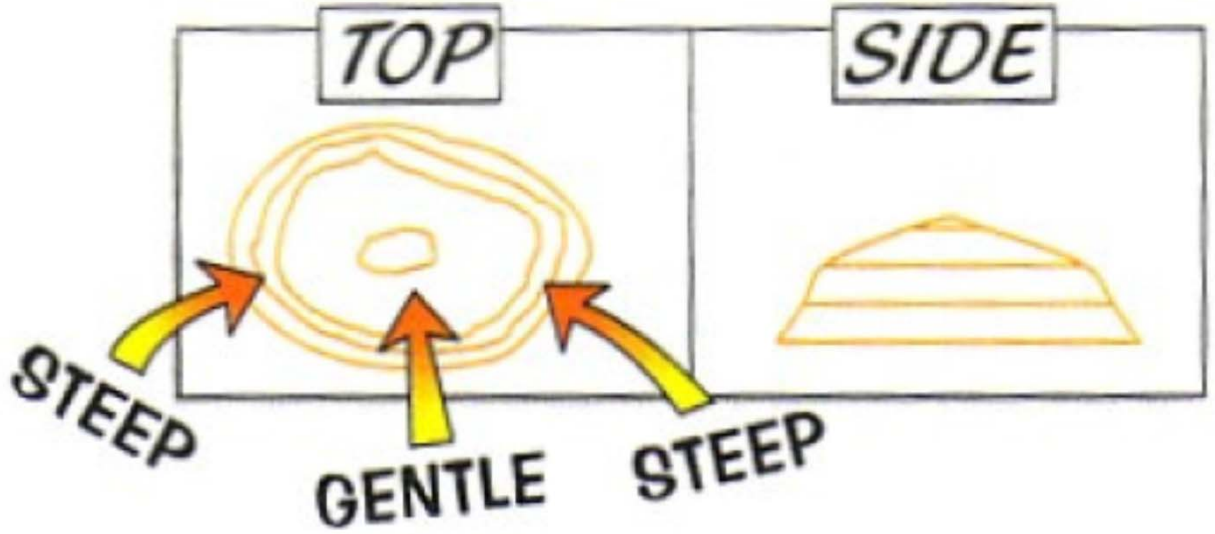
i) All points in a contour line have the same elevation.

ii) Flat ground is indicated where the contours are widely separated and steep slope where they run close together.

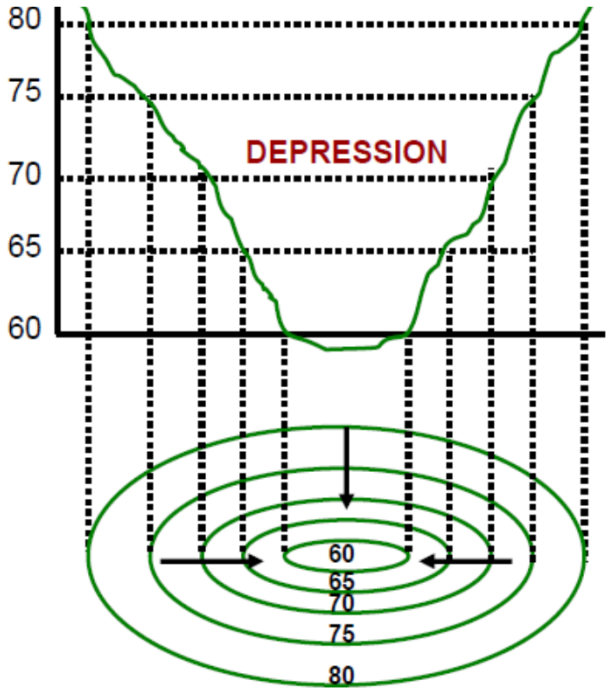
iii) A uniform slope is indicated when the contour lines are uniformly spaced and

iv) A plane surface when they are straight, parallel and equally spaced.

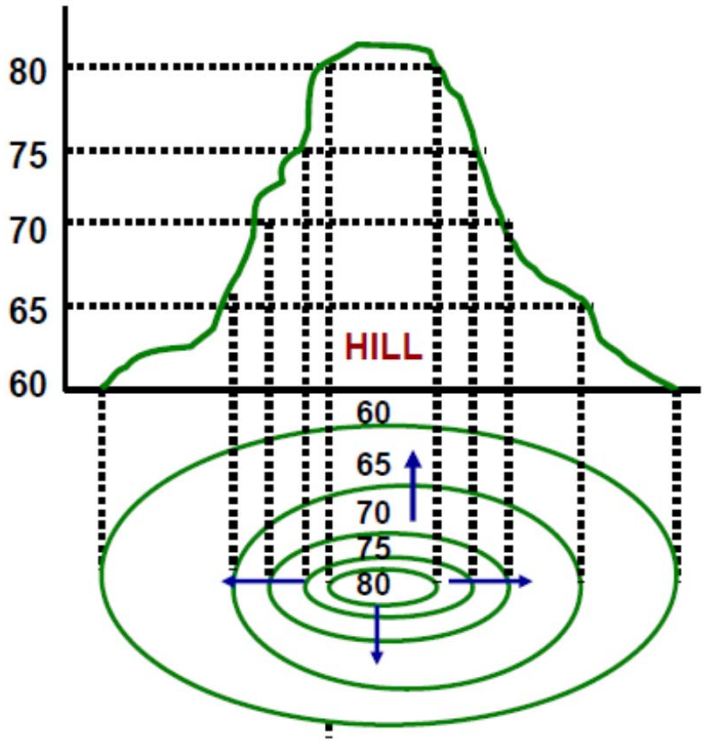

TOP
SIDE
STEEP
GENTLE


TOP
SIDE
STEEP
GENTLE
STEEP

**v)** A series of closed contour lines on the map represent a hill , if the higher values are inside.



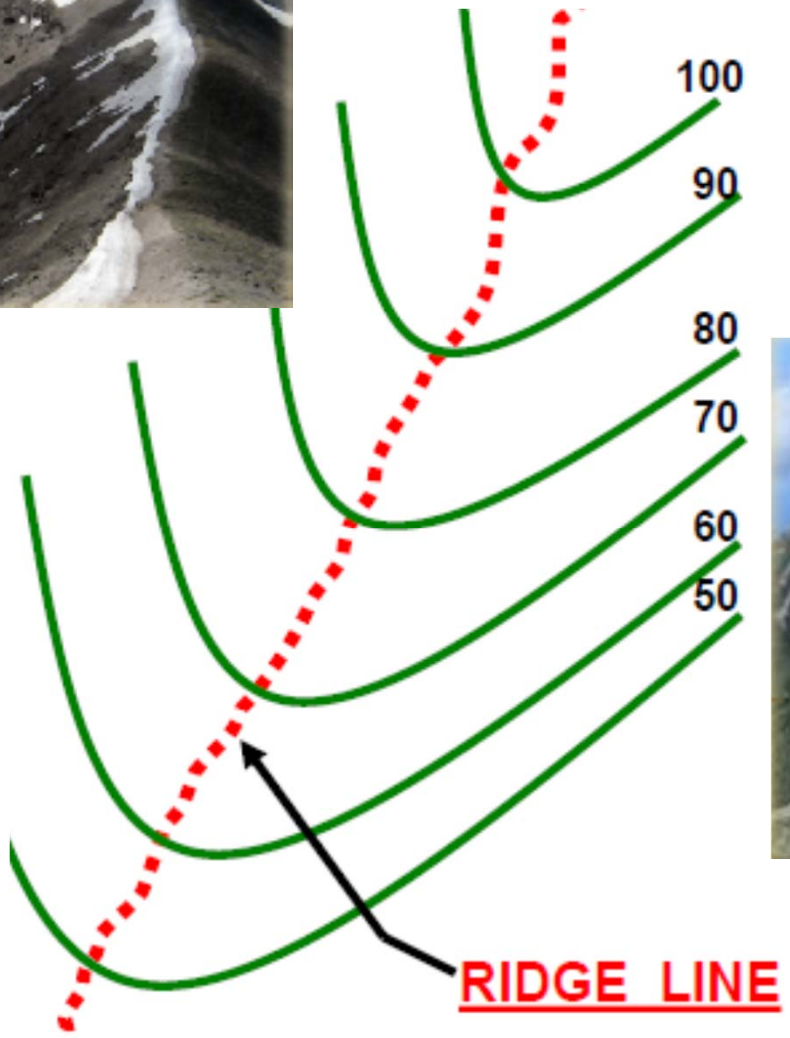

A DEPRESSION




A HILL

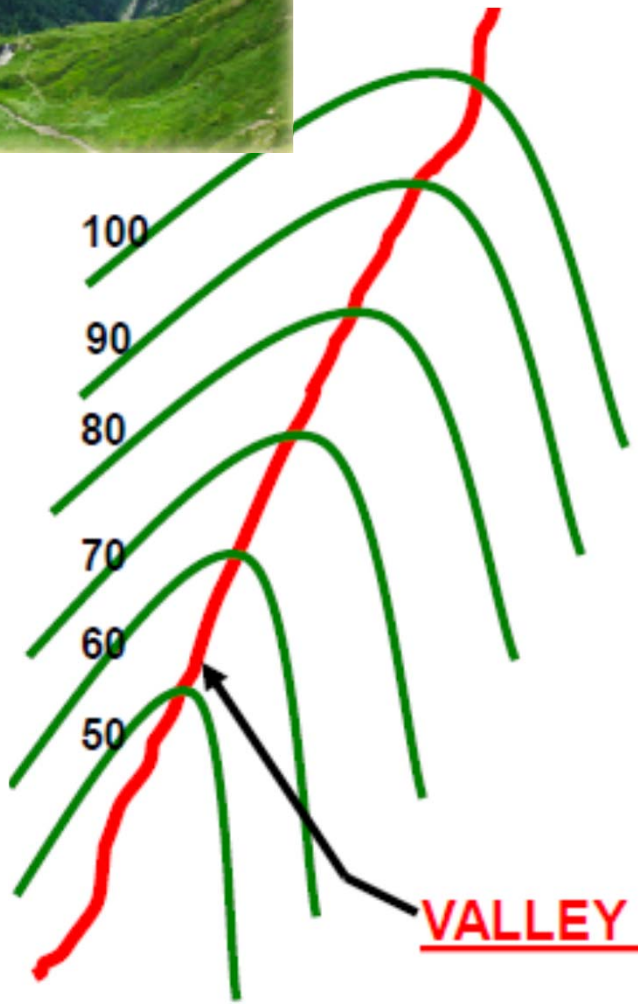
**vi)** A series of closed contour lines on the map indicate a depression if the higher values are outside

(vii) Contour lines cross a ridge or a valley line at right angles.



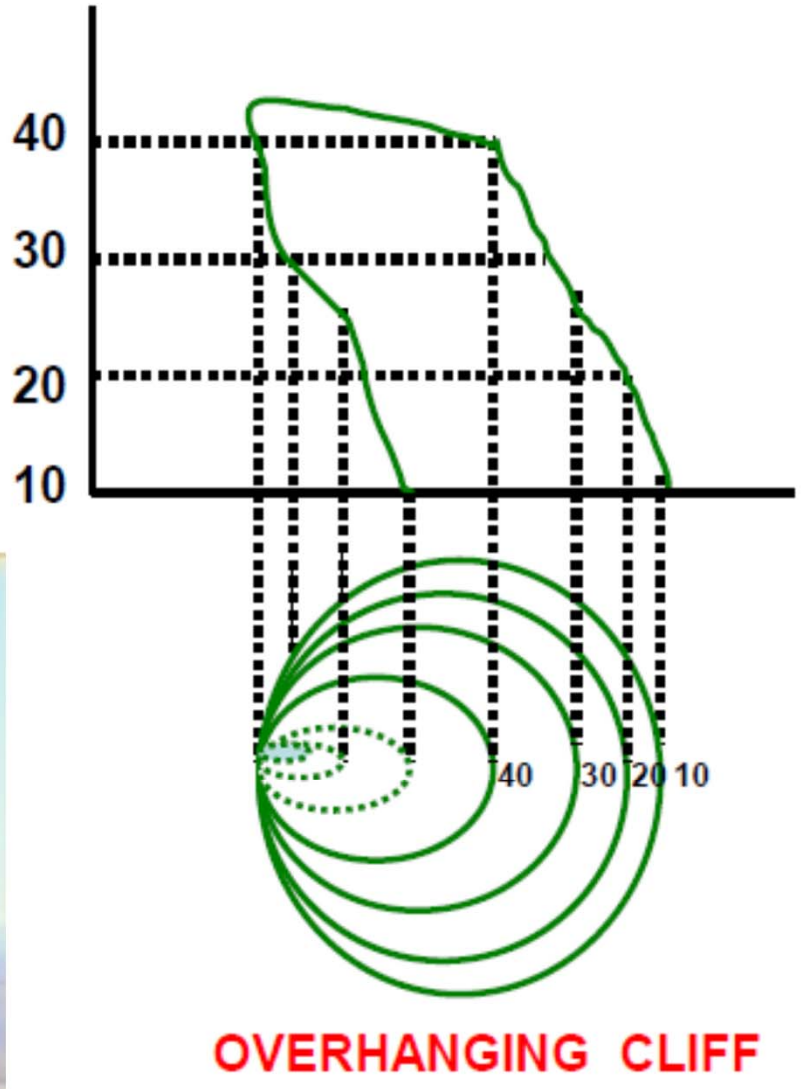

- If the contour lines form **U-shaped** curves and higher values of contour are inside the loop, then it indicates a ridge line.

(vii) Contour lines cross a ridge or a valley line at right angles.



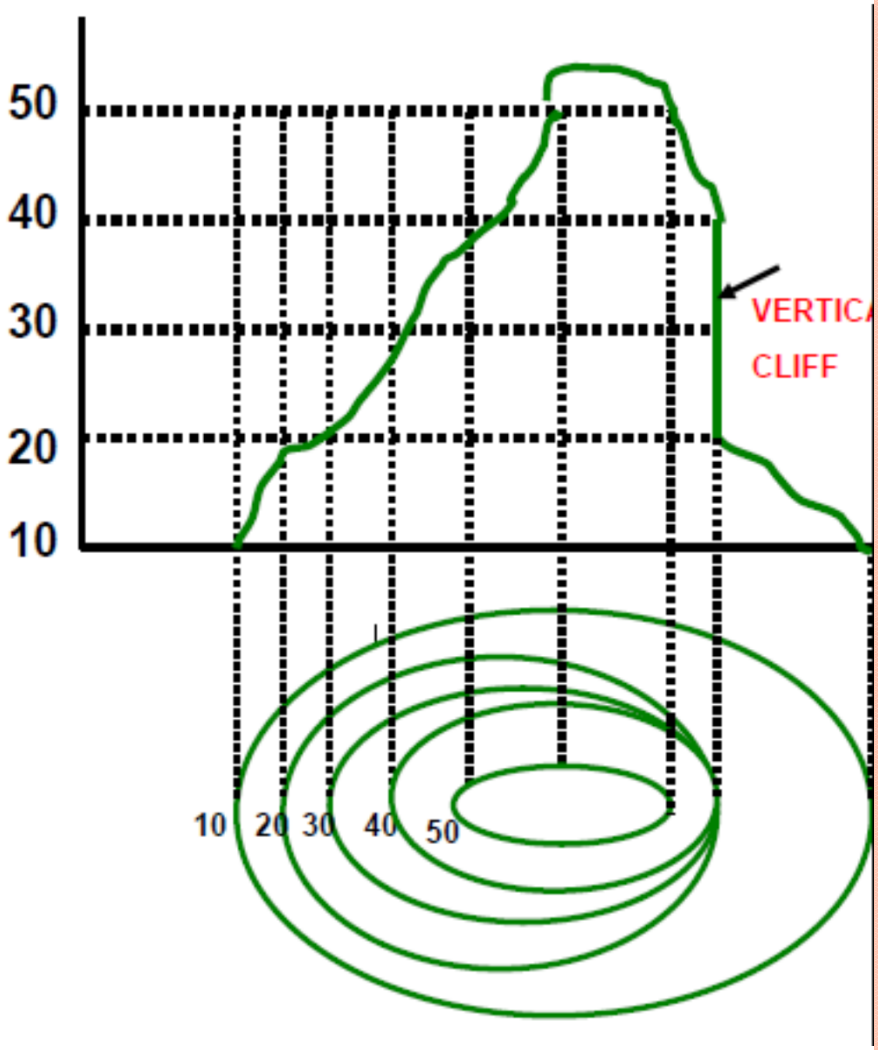

- If the contour lines form **V-shaped** curves and the lower values of contour are inside the loop, it indicates a valley line

(viii) Contour lines cannot merge or cross one another on map except in the case of an overhanging cliff.

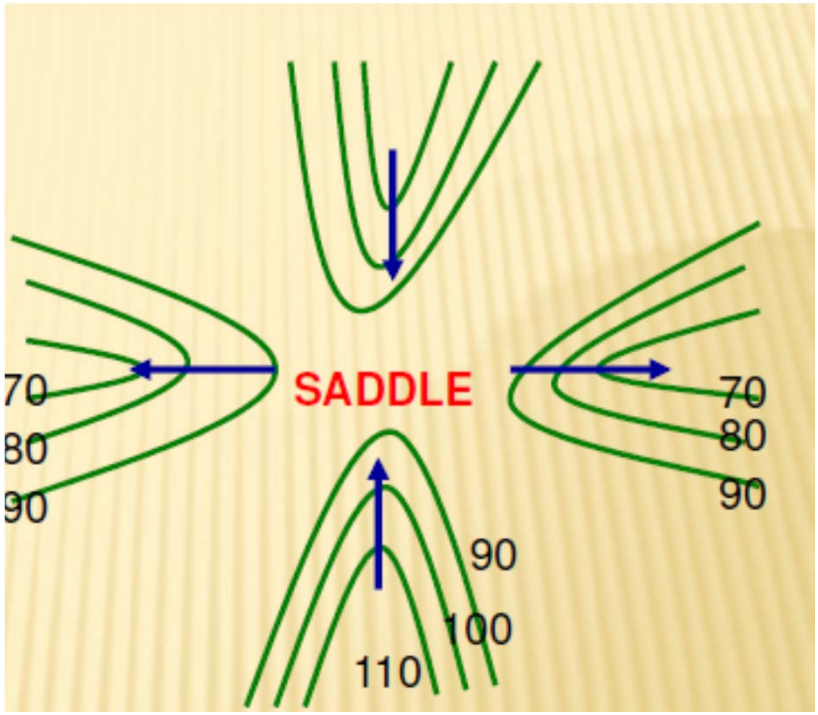


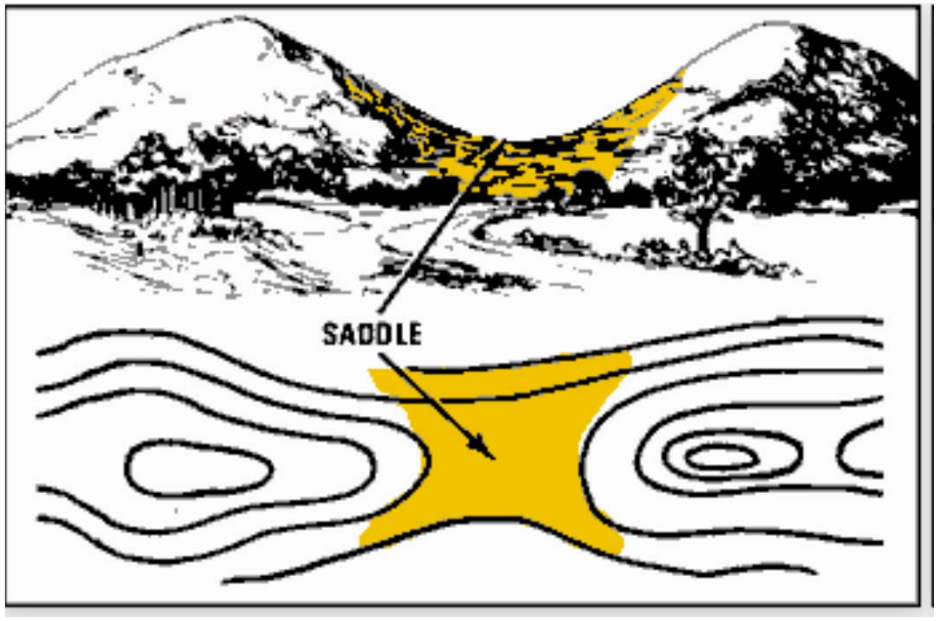

OVERHANGING CLIFF

(ix) Contour lines never run into one another except in the case of a vertical cliff. In this case, several contours coincide and the horizontal equivalent becomes zero.



(x) Depressions between summits is called a saddle. It is represented by four sets of contours as shown. It represents a dip in a ridge or the junction of two ridges. And in the case of a mountain range , it takes the form of a saddle



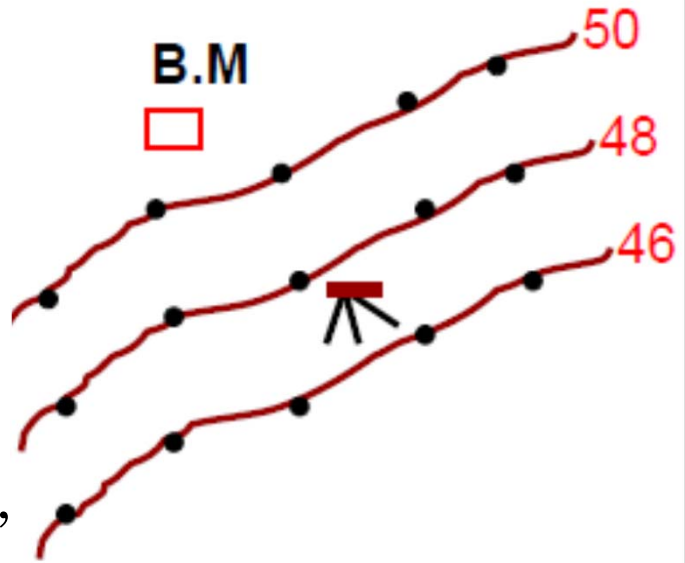
# METHODS OF LOCATING CONTOURS

There are mainly two methods of locating contours

(i) **Direct method,** (ii) **Indirect method**

## (i) Direct Method

- In the **direct method**, the contour to be plotted is actually traced on the ground.
- Only those points are surveyed which happen to be plotted.
- After having surveyed those points, they are plotted and contours are drawn through them.
- The method is slow and tedious and is used for small areas and where great accuracy is required.




DIRECT METHOD OF CONTOURING

## Procedure:

- To start with, a temporary B.M is established near the area to be surveyed with reference to a permanent B.M by *fly leveling*.
- The level is then set up in such a position so that the maximum number of points can be commanded from the instrument station.
- The height of instrument is determined by taking a back sight on the B.M. and adding it to the R.L. of bench mark.
- The staff reading required to fix points on the various contours is determined by subtracting the R.L. of each of the contours from the height of instrument.

## Example:

- If the height of instrument is 82.48m., then the staff readings required to locate 82, 81 and 80m contours are 0.48, 1.48 and 2.48m respectively.
- The staff is held on an approximate position of point and then moved *up* and *down* the slope until the desired reading is obtained.
- The point is marked with a peg.
- Similarly various other points are marked on each contour.
- The line joining all these points give the required contour.
- It may be noted that one contour is located at a time.
- Having fixed the contours within the range of the instrument, the level is shifted and set up in a new position.

## Procedure (Contd.....)

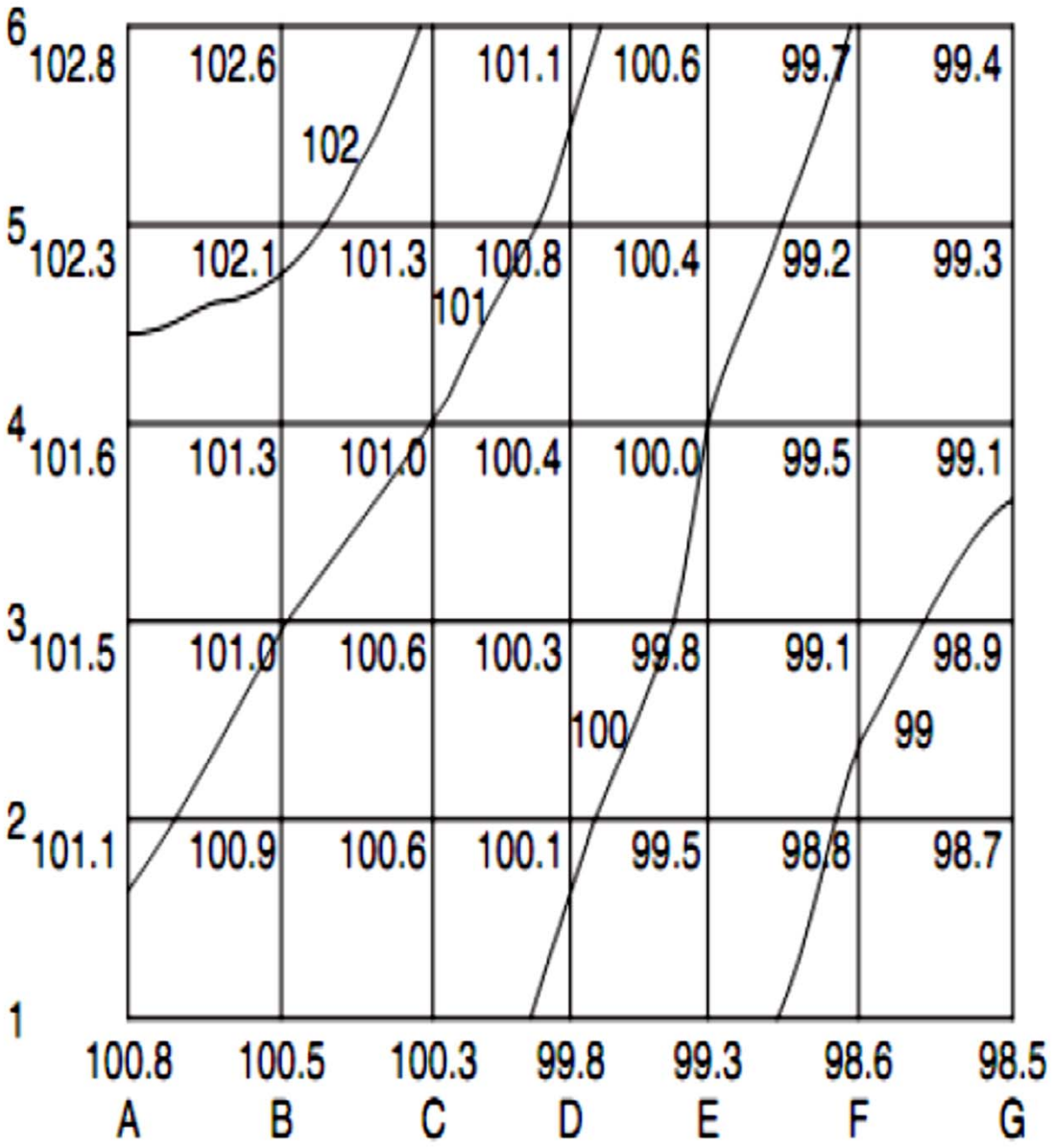
- The new height of instrument and the required staff readings are then calculated in a similar manner and the process repeated till all the contours are located.
- A theodolite, a compass or a plane table traversing is usually adopted for locating these points.
- The points are then plotted on the plan and the contours drawn by joining the corresponding points by dotted curved lines.

# INDIRECT METHOD

- In the **indirect method**, some suitable guide points are selected and surveyed; the guide points need not necessarily be on the contours.
- These guide points, having been plotted, serve as basis for the interpolation of contours.
- This is the method most commonly used in engineering surveys.

# INDIRECT METHOD (BY SQUARE)

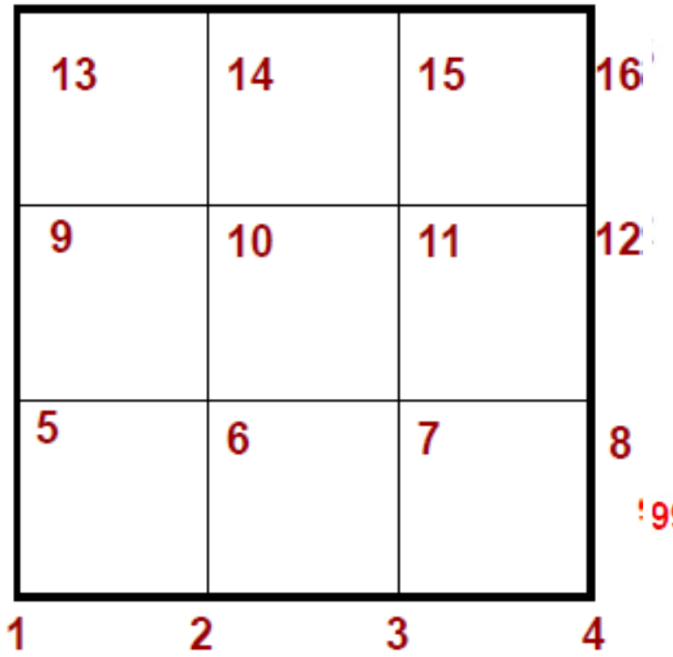
- This method is used when the area to be surveyed is small and the ground is not very much undulating.
- The area to be surveyed is divided into a number of squares.
- The size of the square may vary from 5 to 20m depending upon the nature of the contour and contour interval.
- The elevations of the corners of the square are then determined by means of a level and a staff.
- The contour lines may then be drawn by interpolation.
- It is not necessary that the squares may be of the same size.
- Sometimes, rectangles are also used in place of squares.
- The squares should be as long as practicable, yet small enough to conform to the inequalities of the ground and to the accuracy required.
- The method is also known as spot levelling.



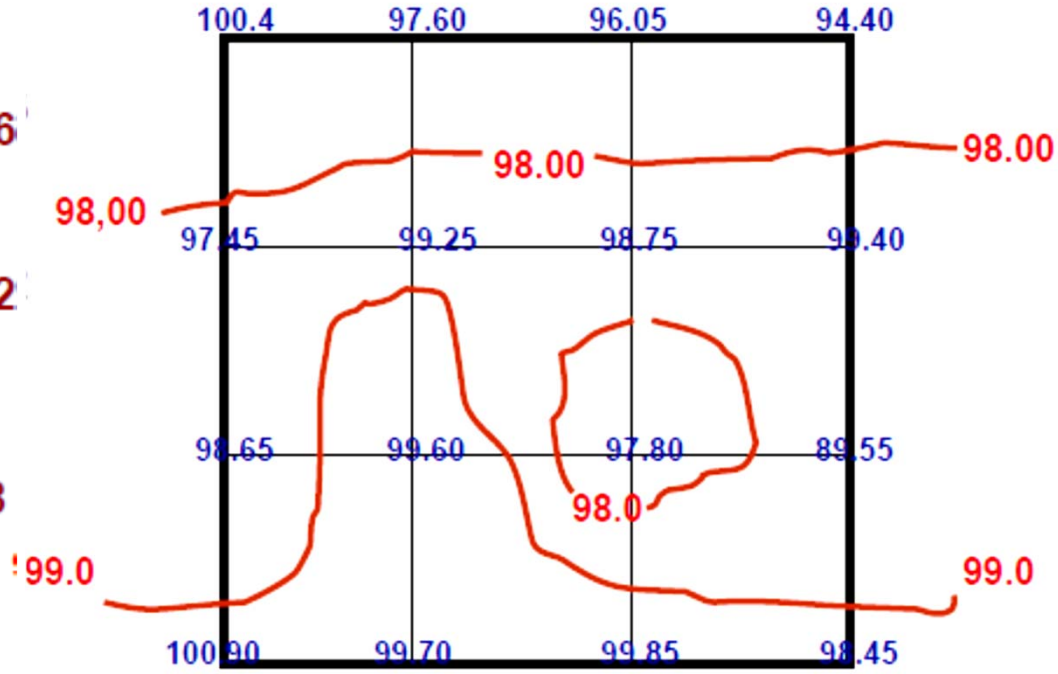

## SQUARE METHOD

# INDIRECT METHOD (BY SQUARE)

The corners of the squares are pegged out and the reduced levels of these points are determined with a level.




SQURES LAID ON GROUND




CONTOURS INTERPOLATED

# INDIRECT METHOD (BY CROSS-SECTION)

- This method is most suitable for the survey of long narrow strips such as a road, railway or canal etc.

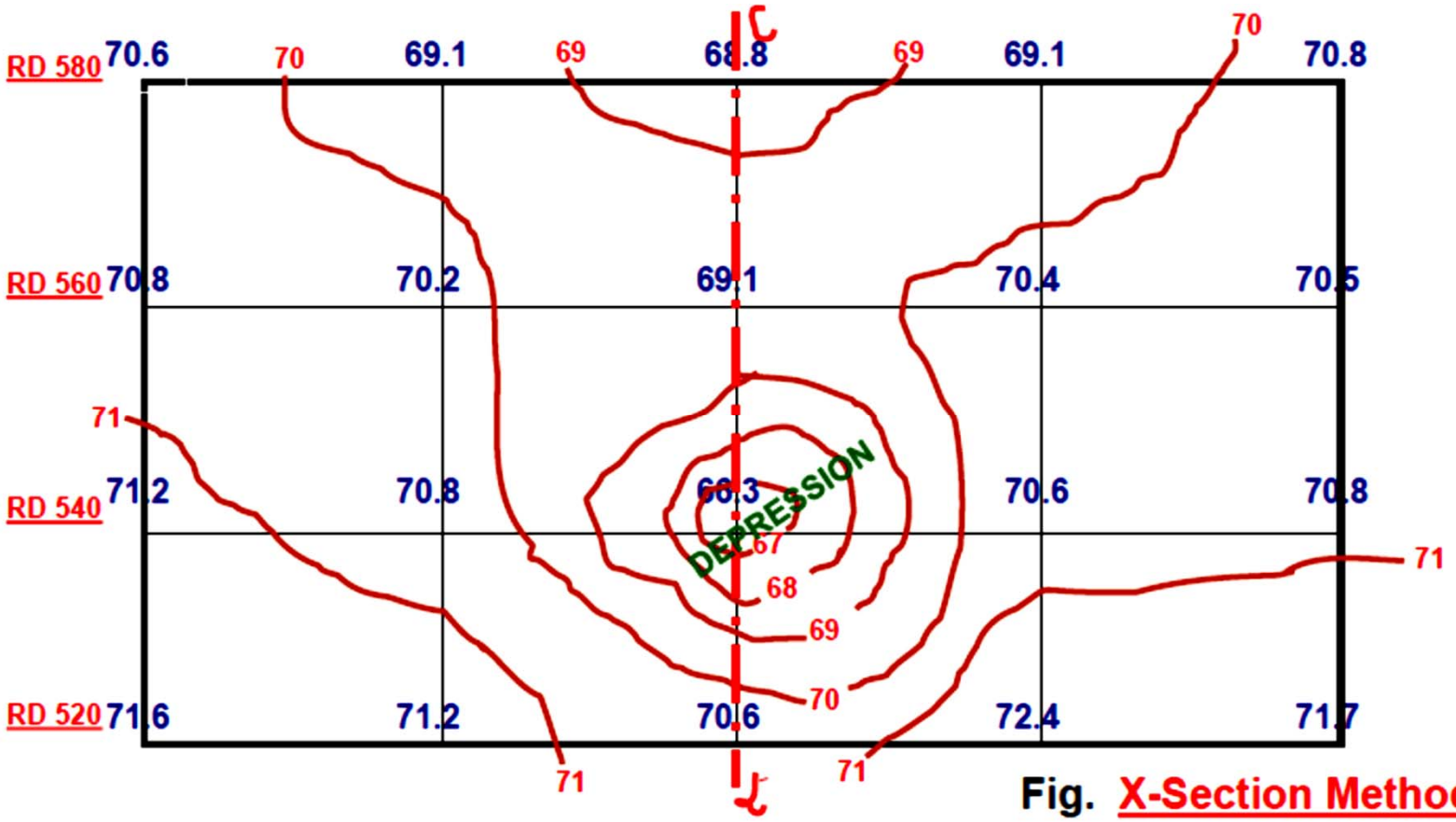



Fig. X-Section Method

# INDIRECT METHOD (BY CROSS-SECTION)

- This method is most suitable for the surveys of long narrow strips such as a road, railway or canal etc.
- Cross sections are run transverse to the center line of the work and representative points are marked along the lines of cross-section.
- The cross-section lines need not necessarily be at right angles to the center line of the work. This may be inclined at any angle to the center line if necessary.
- The spacing of the cross-sections depends upon the topography of the country and the nature of the survey.
- The common value is 20 to 30 m in hilly country and 100 m in flat country.
- The levels of the points along the section lines are plotted on the plan and the contours are then interpolated as usual as shown in the fig.

# INTERPOLATION OF CONTOURS

- The process of *spacing the contours proportionally* between the plotted ground – points is termed as *interpolation of contours* .
- This becomes necessary in the case of indirect contouring as only the spot levels are taken in this method.
- While interpolation of contours the ground between any two points is assumed to be uniformly sloping.

There are three main methods of interpolation:

**i) By Estimation**

**ii) By arithmetical calculation**

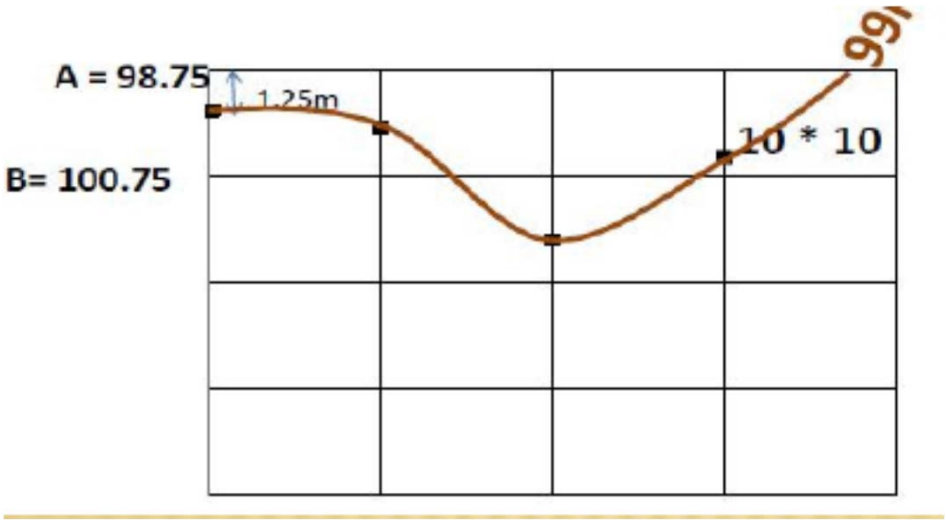
**(iii) By Graphical method**

## i) By Estimation

The position of the contour points between ground - points are estimated roughly and the contours are then drawn through these points. This is a rough method and is suitable for small scale maps.

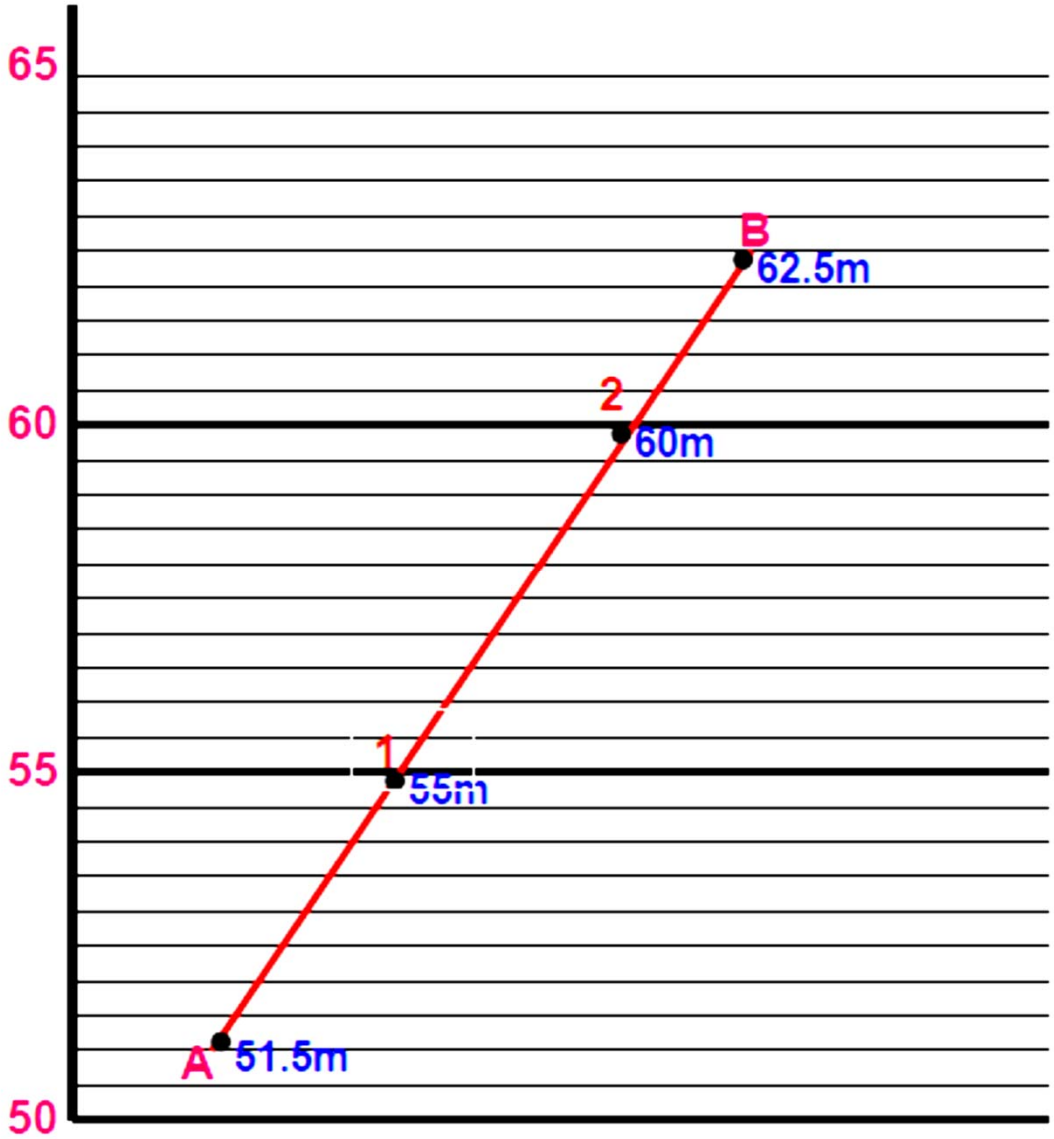
## ii) By arithmetical calculation:

- This is very tedious & time consuming but accurate method.
- The positions of contour points between the guide points are located by arithmetic calculation.
- Used for small areas where accurate results are necessary




**Find distance from A for a contour of 99m elevation.**
**(Note – Square = 10*10m)**
**•Distance from A for contour of 99m**
**= (99—98.75)/ (100.75 —98.75) *10**
**= 1.25m**

# (iii) By Graphical method (H.W.)



# DRAWING THE CONTOUR LINES

- Contour lines are drawn as fine and smooth free hand curved lines.
- They are inked in either in **black** or **brown** colour.
- A drawing pen gives a better line than a writing pen and French curves should be used as much as possible.
- Every fifth contour is made *thicker* than the rest.
- The elevation of contours must be written in a uniform manner, either on the higher side or in a gap left in the line.
- When the contour lines are *very long*, their *elevations are written at two* or *three places* along the contour.
- In the case of small scale maps, it is sufficient to figure every *fifth* contour.

# THANKS